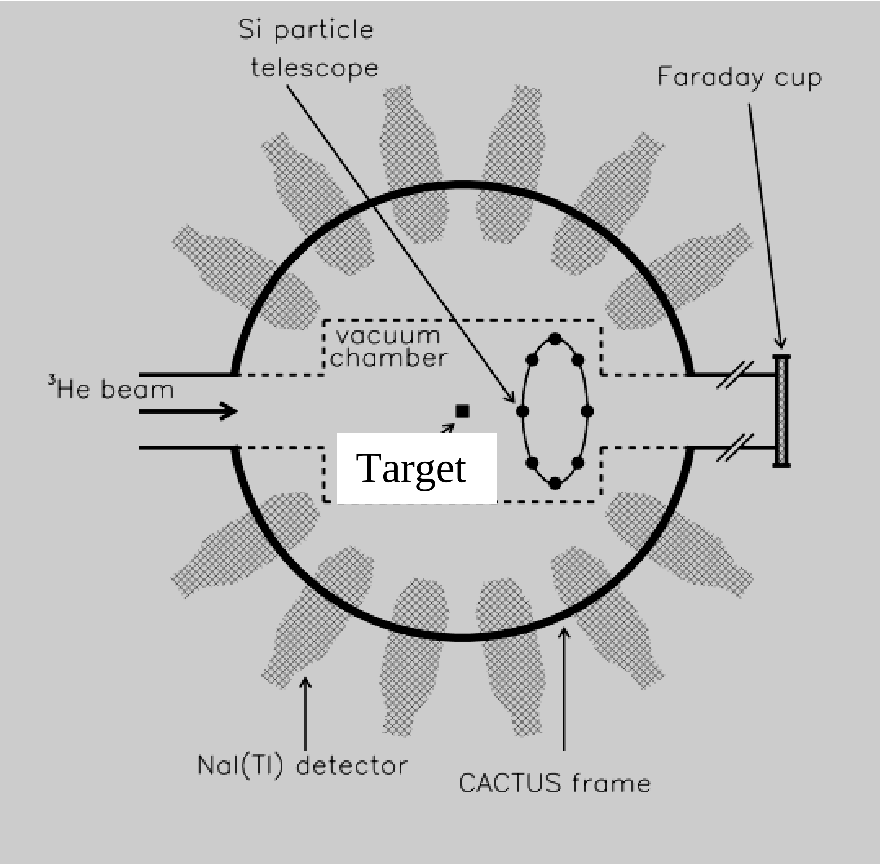
Comparing the total γ-ray spectrum for ^{117}Sn from the (^{3}He,^{3}He γ) and (n,γ) reactions

U. Agvaanluvsan[1,2,3], J.A. Becker[3], L.A. Bernstein[3],
M. Guttormsen[4], G.E. Mitchell[1,2], A. Schiller[5], A. Voinov[6]

[1]North Carolina State University, Raleigh, NC
[2]Triangle Universities Nuclear Laboratory, Durham, NC
[3]Lawrence Livermore National Laboratory, Livermore, CA
[4]University of Oslo, Oslo, Norway
[5]Michigan State University, East Lansing, MI
[6]Frank Laboratory of Neutron Physics, Dubna, Russia

Nuclear Reactions on Unstable Nuclei and the Surrogate Reaction Technique,
January 12-15, 2004, Asilomar, CA

Equipment

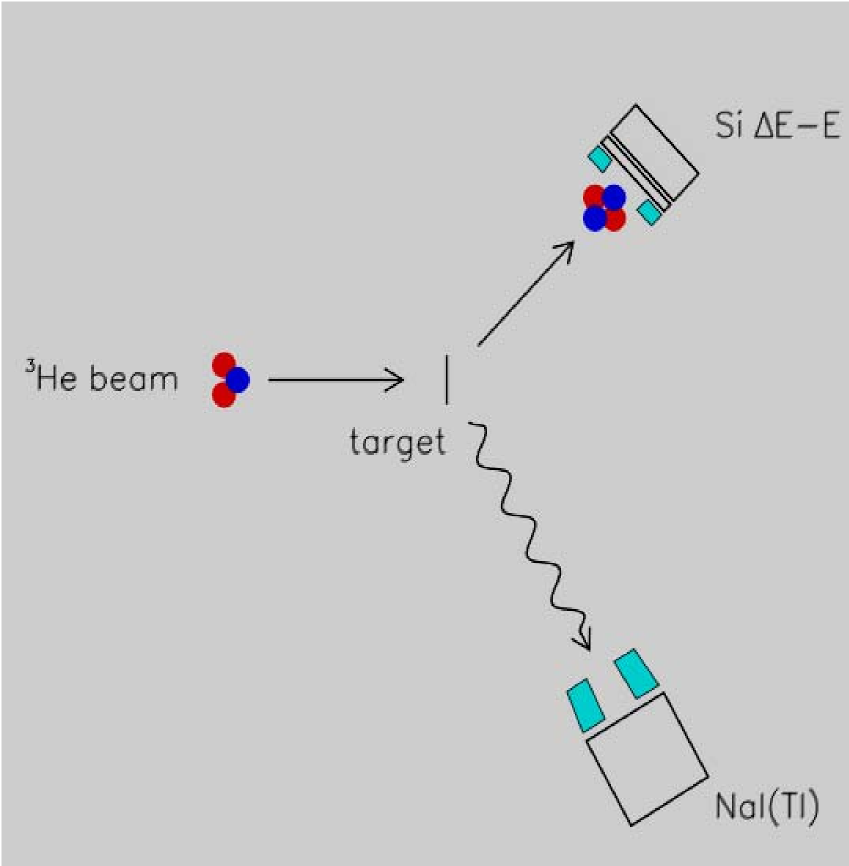


Oslo University Cyclotron CACTUS
multi-detector array

• Eight ΔE-E Si particle telescopes at 45^o
• 28 5"×5" NaI(Tl) detectors, ~15% of 4π
• Three Ge(HP) detectors

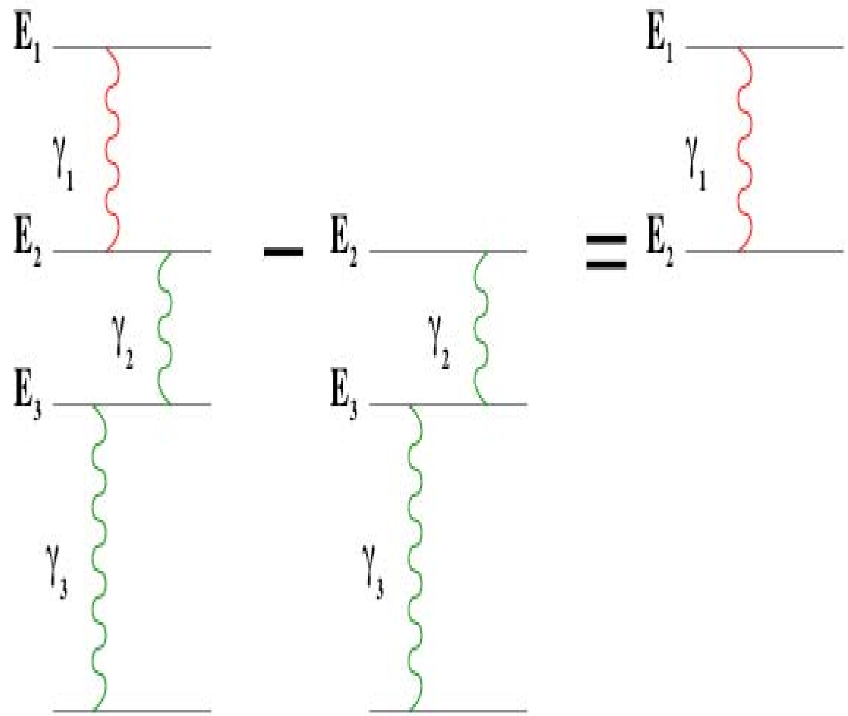
Experimental set-up

- ^{117}Sn self-supporting target of thickness 2.1 mg/cm^2
- 38 MeV ^{3}He beam
- ^{117}Sn(^{3}He,^{3}He')^{117}Sn and ^{117}Sn(^{3}He,α)^{116}Sn reactions are studied
- Particle-γ measured in coincidence



Basic idea

Level densities and strength functions are obtained using the primary gamma-rays



$$P(E_x, E_\gamma) \propto \rho(E_x - E_\gamma) T(E_\gamma)$$

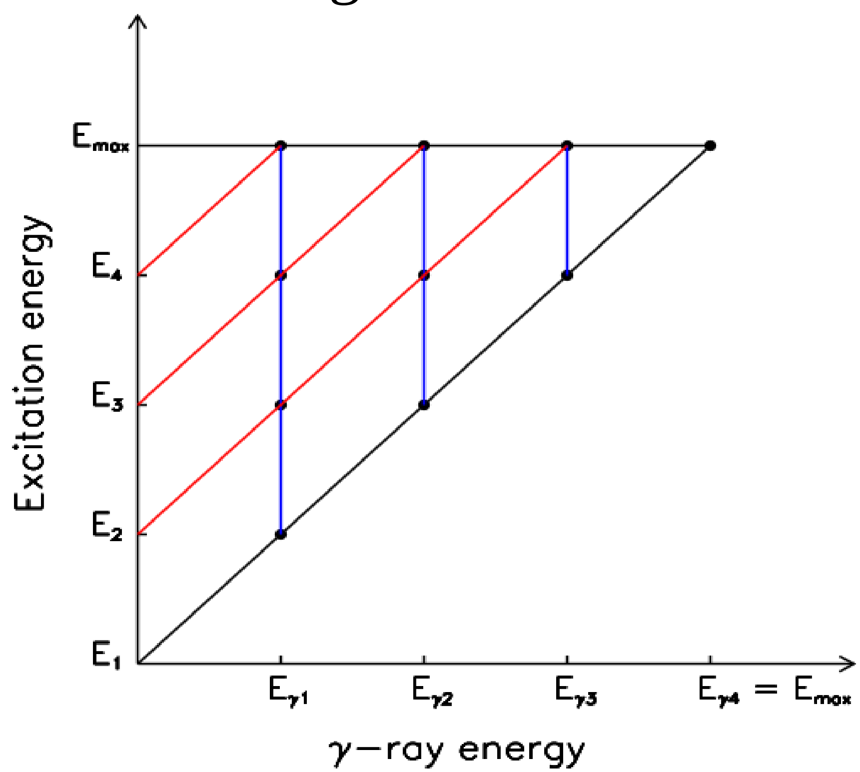
ρ-level density at final energy

T-strength of γ-ray

Method

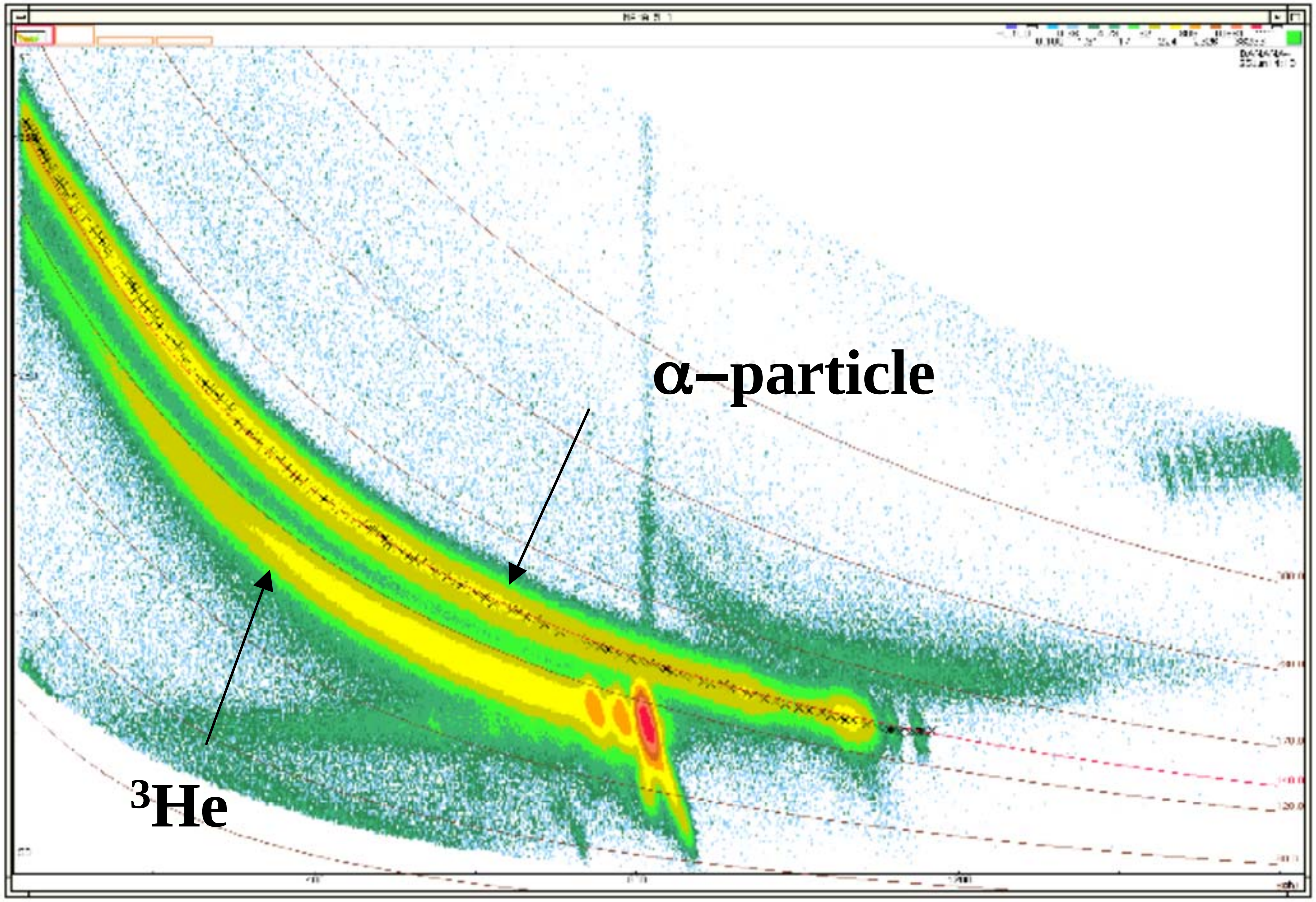
- Particle-γ coincidence
- Particle energy $\rightarrow$ excitation energy E_x
- E_x vs. E_γ matrix $P(E_x, E_\gamma)$
- Extract level density and radiative strength function

Simple primary
γ-ray matrix $P(E_x,E_\gamma)$



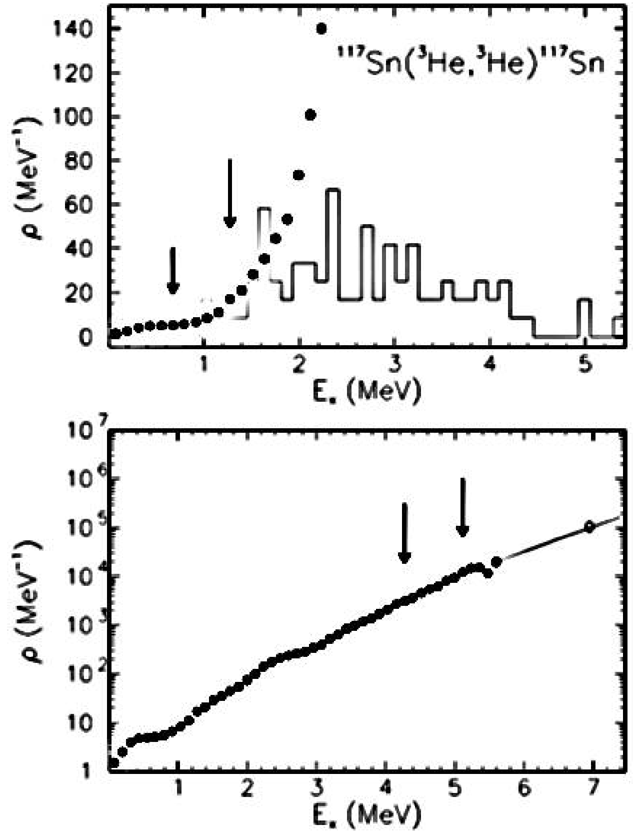
M. Guttormsen et al.
Nucl. Phys. A573, 130 (1994)
A. Schiller et al.
NIM A 447, 498 (2000)
references therein

Charged particle identification

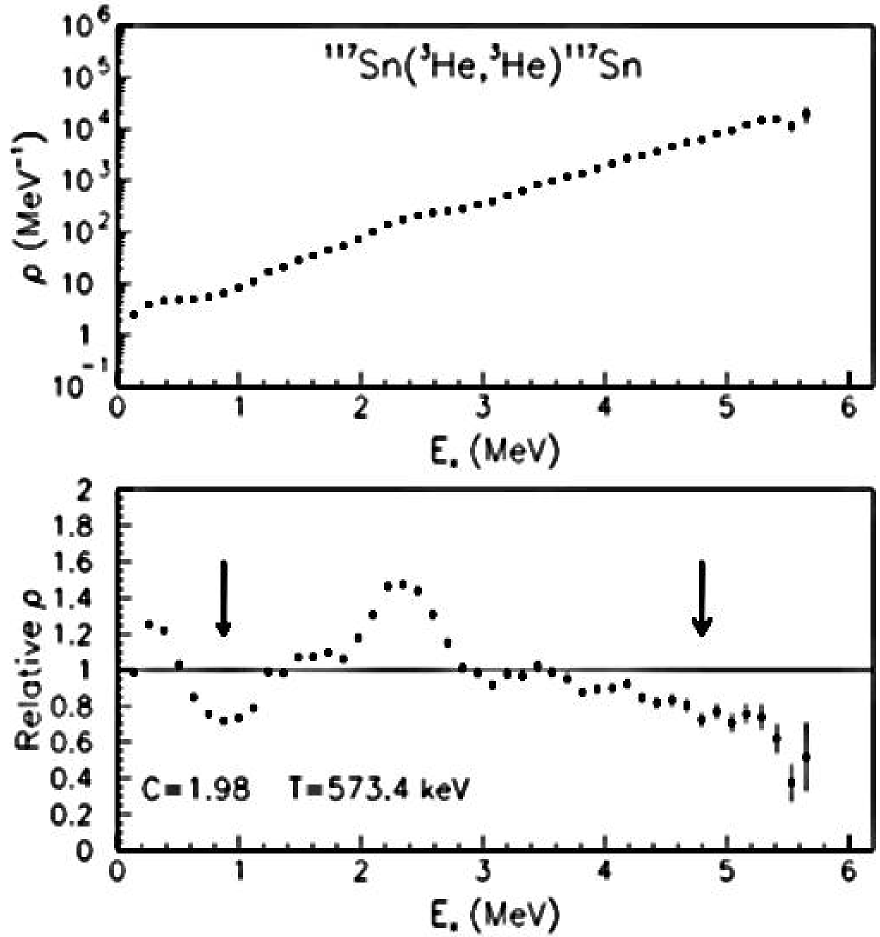


Normalizing the level density

- At low excitation energy, data is compared to discrete levels
- Near B_n, normalized to the level density value obtained from the neutron resonance spacing

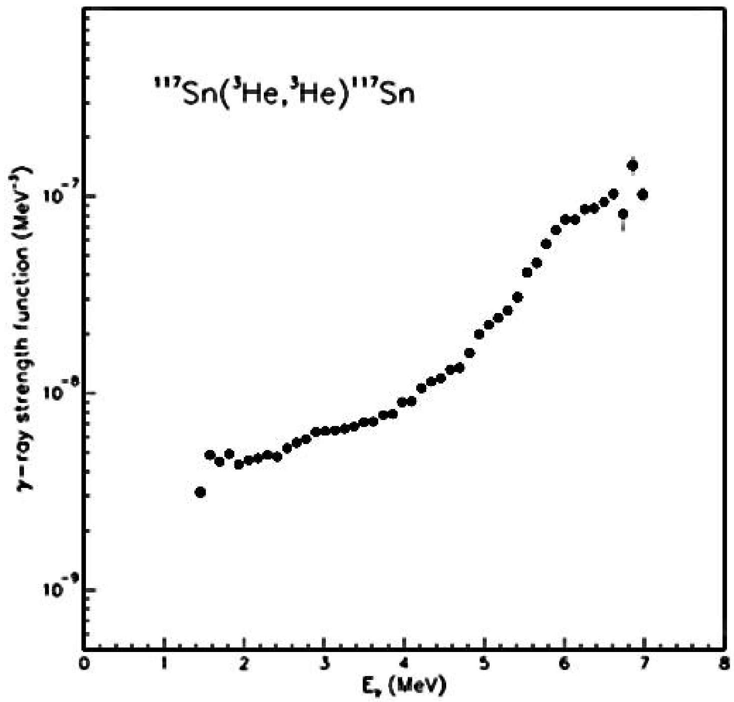


The level density in ^{117}Sn



The radiative strength function in ^{117}Sn

- The γ-ray strength function is normalized using the radiative width



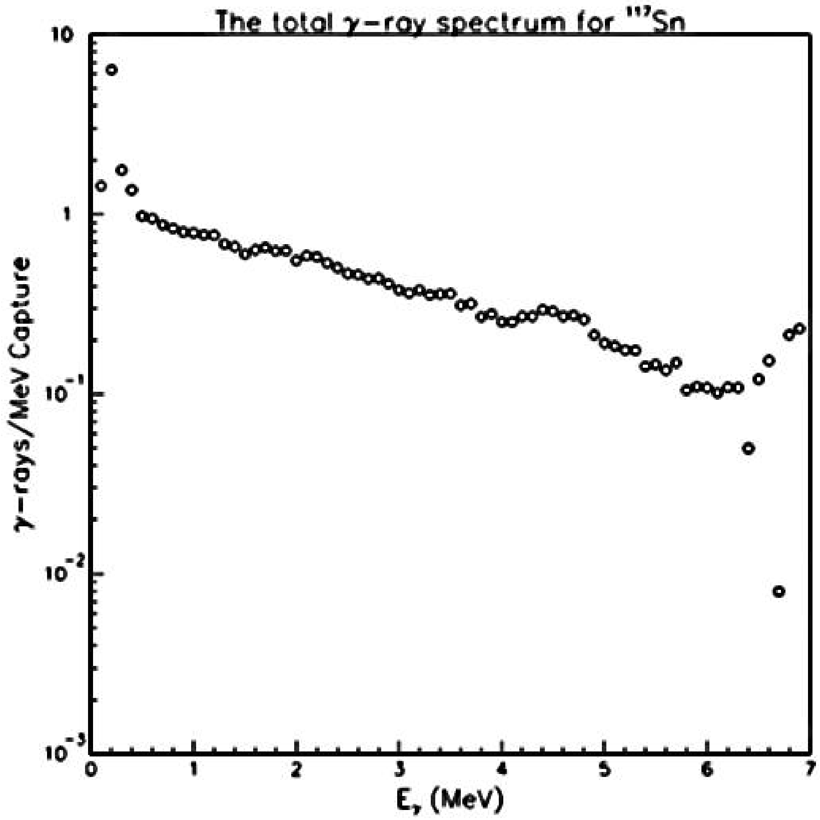
Calculation of the total γ–ray spectrum

Using the observed strength function f and level density ρ

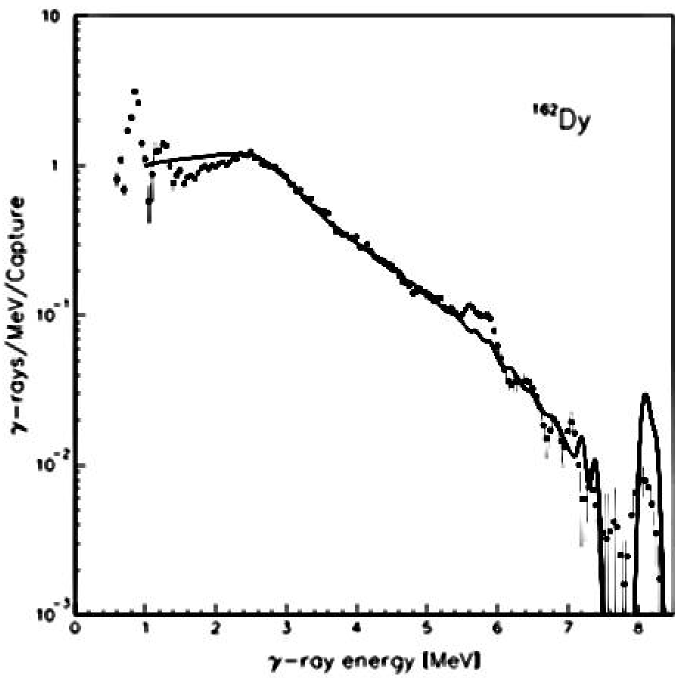
$$P(E_\gamma) = \frac{\Gamma_i(E_\gamma)}{\Gamma}$$

$\Gamma_i(E_\gamma)$–partial γ width of state i
Γ - total γ width

$$\Gamma_i(E_\gamma) = \frac{f_\gamma^{XL}(E_\gamma) \times E_\gamma^{2L+1}}{\rho(E_i)}$$



Comparison of total γ-ray spectra

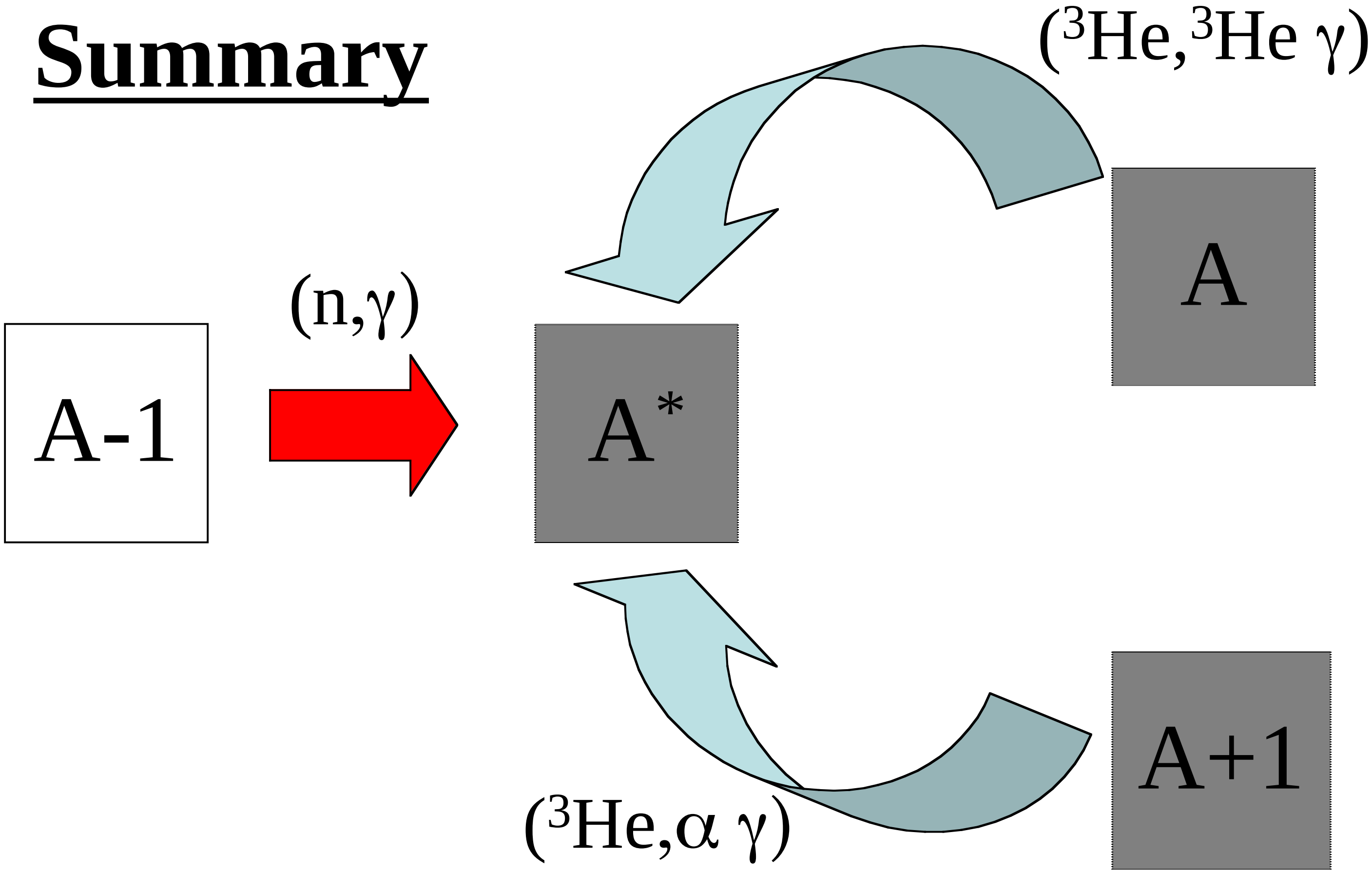


Data points: **^{162}Dy(n,γ)** reaction

Solid line: Calculated
spectrum using the observed
level density and strength function
from **^{163}Dy(^{3}He, αγ)** reaction

Reference: A. Voinov et al. PRC 63, 044313

Summary



Using the level densities and strength functions measured with stable nuclei, one can refer information about the decay properties of the neighboring unstable nuclei.